IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re patent application of
Frederic BELLOTT et al.
Corres. to PCT/EP2004/000560
For: HEAT EXCHANGER

VERIFICATION OF TRANSLATION

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Sir:

I, Susan ANTHONY BA, ACIS,

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Date: July 8, 2005

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# Heat Exchanger

The invention relates to a heat exchanger, in particular for motor vehicle air conditioning systems according to the preamble of patent claim 1.

Heat exchangers are frequently composed essentially of a heat exchanger network or tube/rib block and collecting tubes which are arranged on both sides. The tubes of the heat exchanger network are usually flat tubes between which corrugated ribs are arranged in order to increase the size of the air-side heat exchanging face. The flat tubes are accommodated by their ends in passages of the collecting tubes. These parts of the condenser are first joined together mechanically and then soldered in an operation in a soldering oven. The parts are often composed of an aluminum alloy and have solder plating on their surface. In addition, many such heat exchangers have connecting tubes, i.e. for example a coolant inlet tube for the gaseous phase and a coolant outlet tube for the liquid phase of a coolant. The connecting tubes are connected, for example by means of a flange, to the coolant lines of the coolant circuit of a motor vehicle air conditioning system. Hitherto, after the soldering process the coolant connecting tubes were soldered into corresponding openings in the collecting tube by hand, i.e. using a soldering flame, and the flange was also not mounted until after the soldering process, for example attached to a holding element which has already been soldered to the collecting tube in the soldering oven. The problem with soldering additional parts to the heat exchanger in the soldering oven is to secure these additional parts so that they retain their predetermined position during the soldering process and after the soldering process the condenser is also dimensionally accurate with respect to these additional parts. In order to secure such additional parts it is

known to use soldering devices which keep the parts to be soldered in the desired position. After the soldering, the soldering device must be removed. Such soldering devices are disadvantageous since they require additional mounting time and also consume energy as a result of their heating up.

The object of the present invention is to improve a heat exchanger of the type mentioned at the beginning to the effect that a holding element can be simultaneously soldered to the heat exchanger without a soldering device or similar resources and is soldered in its intended position after the soldering process.

This object is achieved by the features of patent claim 1. According to the invention, this is done by positively locking engagement securing the holding element in a way which is sufficient to keep it in position during the soldering process. This provides the advantage that the holding element can be soldered to the heat exchanger in one operation without a soldering device and similar resources. This saves considerable mounting time and reduces the manufacturing costs of the heat exchanger. Advantageous refinements of the invention emerge from the subclaims.

According to a first advantageous refinement of the invention, the shape of the holding element is adapted to the external shape of the collecting tube. In particular, the holding element is constructed with a C-shaped section, whose rounded shape is adapted to the rounded shape of the collecting tube and surrounds it. This results in soldering in the region of the contact face. It is also advantageous if the C-shaped section is clipped to the collecting tube. This may be done by means of corresponding latching or clamping elements on the limbs of the C-shaped section. The holding element with the C-shaped section is therefore simply pressed

onto the collecting tube from above during the mounting process and is then secured after the clipping process.

One advantageous development provides for the collecting tube to be constructed in two pieces, that is to say from a bottom piece and a lid piece, which are soldered to one another by means of two longitudinal seams. Since the lid part and the bottom part overlap in the region of the longitudinal seams, a shoulder is provided in the region of the longitudinal edge. The C-shaped section engages with its limbs in this shoulder or is supported on this shoulder. This further improves the securing of the holding element, in particular if clipping takes place at the same time.

According to a further advantageous configuration of the invention, a flange for securing connecting tubes is attached to the collecting tube by means of the holding element, in particular by way of a web. The holding element is preferably constructed in one piece with the flange, with the embodiment as an extruded section being particularly advantageous. The holding element therefore does not need to be connected to the flange after the soldering process, for example by additional screws or rivets. The flange is thus secured to the collecting tube by way of the holding element and can be soldered to the heat exchanger. This saves mounting time once more.

According to one advantageous development of the invention, the connecting tubes are also attached to the flange and to the collecting tube so that these parts can also be soldered tight to the heat exchanger in one operation. This step also shortens the manufacturing time and reduces the fabrication costs.

According to a further advantageous embodiment of the invention, an extruded flange with holding element which has a concave section with a longitudinal groove

is secured to the collecting tube by means of a securing piece by caulking and clamping. This provides the advantage that the connecting flange can be soldered to connecting pipes in the soldering oven without further mounting operations for attaching the flange being necessary after the soldering.

In a further embodiment of the invention, the holding element is in the shape of a plate-shaped web with bent side faces or limbs whose lower edges are adapted to the rounded shape of the collecting tube. As a result, these bent limbs have a supporting function so that the holding element cannot tilt on the collecting tube during the soldering processes but is instead fixed. As a result, a securing process is carried out by means of a positive fit in this embodiment of the holding element also.

According to one advantageous development of the invention, the holding element has, on its lower edge a lug which is plugged into a corresponding slot in the collecting tube. This provides a further improvement of the securing of the holding element with respect to the collecting tube since, in this way, a further positive fit is formed. As a result, this holding element which serves for the subsequent attachment of the tube flange can be soldered in a dimensionally accurate fashion to the heat exchanger in the soldering oven.

According to a further advantageous refinement of the invention, the holding element is embodied as an extruded part. This provides the advantage of a soldering face which is increased in size, i.e. the holding element can be loaded to a greater extent. Furthermore, the advantage of lower manufacturing costs compared to a pressed holding element is obtained.

In a further advantageous refinement of the invention, the holding element has a C-shaped section with a central rib, i.e. as it were an E-shaped section. The rib is plugged into a corresponding slot in the collecting tube and caulked - and in this way the holding element is secured and can be soldered in the soldering oven without further securing means. At the same time, the advantage is obtained of more accurate positioning of the holding element by means of a rib and a slot.

In a further refinement of the invention, the holding element has a holding plate which adjoins the outside of the C-shaped section, that is to say is part of the entire extruded section. The holding plate can be bent, curved or else have other shapes which are provided by extrusion within the scope of manufacture. In one advantageous refinement of the holding plate it can have attachment bores or cutouts which are manufactured by further processing, for example by hole punching.

In a further advantageous refinement of the invention, the C-shaped section forms, on its concave side, a soldering face in which grooves which are produced by extrusion are arranged. This provides the advantage of improved soldering because a better flow of solder is made possible by the grooves. The solder can thus be distributed uniformly over the entire soldering face and be soldered there. This provides increased strength for the entire holding element. This advantage thus also results from the manufacturing method by extrusion.

According to a further embodiment, the heat exchanger is embodied as a condenser and preferably soldered. Heat exchanger tubes and ribs which form a tube/rib block are particularly advantageous in this context because of the ease of fabrication.

Exemplary embodiments of the invention are illustrated in the drawing and will be described in more detail below. In the drawing:

Fig. 1 shows a condenser with a flange,

Fig. 2 shows a collecting tube of the condenser,

Fig. 3 shows the flange with a holding element as an elevation,

Fig. 3a shows the flange in a perspective view,

Fig. 4 shows the collecting tube with mounted flange and connecting tubes,

Fig. 5 shows a second exemplary embodiment of a condenser with a holding element,

Fig. 6 shows the holding element according to Fig. 5,

Fig. 6a shows a view from above of the holding element according to Fig. 6,

Fig. 6b shows a view from the side of the holding element according to Fig. 6,

Fig. 7 shows a condenser with extruded holding elements in a view from the front,

Fig. 7a shows the condenser according to Fig. 7 in a view from below,

Fig. 7b shows the condenser according to Fig. 7 in a view from the side,

Fig. 8 shows an extruded holding element,

Fig. 8a shows the extruded holding element according to Fig. 8 in a view from above,

Fig. 8b shows the extruded holding element in a view from below,

Fig. 8c shows the extruded holding element in a perspective illustration,

Fig. 9 shows a detail X from Fig. 8,

Fig. 10 shows a further exemplary embodiment of a flange with a holding element in an exploded illustration, and

Fig. 11 shows the flange mounted according to Fig. 10.

Fig. 1 shows a condenser 1 with a tube/rib block 2, a lower collecting tube 3 and an upper collecting tube 4. The tube/rib block 2 is composed, as is known, or flat tubes (not illustrated in more detail) and corrugated ribs which are arranged between them. Two coolant connecting tubes are arranged on the upper collecting tube 4, with the coolant connecting tubes being specifically a coolant inlet tube 5 and a coolant outlet tube 6 which open into the collecting tube 4 at one end and are held in a flange 7 at the other.

Fig. 2 shows the collecting tube 4 of the condenser 1 according to Fig. 1 partially in a perspective view. The collecting tube 4 is constructed in two parts, i.e. it is composed of a lid 8 and a bottom 9 which has slot-shaped passages 10 for holding the flat tubes of the tube/rib block 2. The lid and bottom parts 8, 9 which are each constructed approximately in the form of a half cylinder overlap in the region of two longitudinal seams 11, 12 and thus form stepped

longitudinal edges 13, i.e. shoulders which run in the direction of the longitudinal edges 13.

Fig. 3 shows the flange 7 from Fig. 1 as an individual part, specifically as an elevation in the direction of the longitudinal axis of the collecting tube 4. The flange 7 is manufactured as an extruded section made of an aluminum extruded alloy and has, at one end, a block 14, a web 15 and a holding element 16 which is embodied as a C-shaped section. The block 14 has two passage openings or connecting openings 17, 18 for attaching the connecting tubes 5, 6 and connecting coolant lines (not illustrated). The further bores 19, 20 are used to attach a connecting flange (not illustrated) for the coolant lines. The C-shaped section 16 has a concave inner face 16a whose rounded shape is adapted to the contour of the lid 8 of the collecting tube 4. In addition, the holding element 16 is defined by two limbs or arms 21, 22 which each end in a flat end region 21a, 22a with the concave internal profile 16a being stepped with respect to the flat end regions 21a, 22a by means of longitudinal edges 16b, 16c.

Fig. 3a shows the flange 7 according to Fig. 3 in a perspective illustration. The figure shows the web 15 which is of flat design and forms the connection between the holding element 16 and block 14 and at the same time provides a certain degree of elasticity.

Fig. 4 shows the flange 7 with a holding element 16 mounted on the lid 8 of the collecting tube 4 together with the coolant connecting tubes 5 and 6. The figure shows that the C-shaped section of the holding element 16 engages around the lid 8 and is supported with its longitudinal edges 16c, 16b on the longitudinal edges 13 of the collecting tube 4. The flat end regions 21a, 22a engage around the collecting tube 4 and the bottom 9 and at the same time cause the holding element 16 to be clipped to the collecting tube 4, which is however

not illustrated in detail. At any rate, this engagement of the holding element 16 causes the flange 7 to be secured with respect to the collecting tube 4, which is supported by the simultaneous securing of the coolant connecting tubes 5, 6. These are inserted, in a way which is not illustrated in more detail, with their ends into corresponding openings in the lid 8 and caulked there. The other ends of the coolant connecting tubes 5, 6 are correspondingly received in the bores 17, 18 of the flange 7. In this respect, the flange 7 is supported and secured to the collecting tube 4 at 3 points, specifically by the coolant connecting tubes 5, 6 on the one hand, and by means of the holding element 16 on the other. The entire condenser can thus be soldered with the parts illustrated in Fig. 4 in one operation in a soldering oven (not illustrated). After soldering, the coolant connecting tubes 5, 6 are soldered tight both to the collecting tube 4 and to the flange 7, and the C-shaped section 16 is soldered in the region of its contact face 16a, 16b, 16c and 21a, 22a to the lid 8 and bottom 9 (both are solder-plated).

Fig. 5 shows a further exemplary embodiment of the invention, specifically a condenser 24 with an upper collecting tube 25 to which a holding element 26 is attached. The holding element 26 is, as is explained below, secured to the collecting tube 25 before the soldering process and then soldered to the entire condenser 24 in the soldering oven. In order to secure the holding element 26 on the collecting tube 25, a particular shape is necessary, which is explained below.

Fig. 6 shows the holding element 26 from Fig. 5 as an individual part. Fig. 6a shows the holding element 26 in a view from above, and Fig. 6b shows it in a view from the side. The holding element 26 has a planar central web part 27 which is embodied as an attachment

plate and in which two attachment bores 28, 29 are arranged. On both sides of the central web part 27, the holding element 26 has limbs 30, 31 which are bent at an approximate right angle to the radius R. As is shown by Fig. 6a, the central web 27 and the two bent limbs 30, 31 produce a type of U-shaped section. The holding element 26 has a lower edge 27a in the region of the central web 27, with the lower edge 27a being adjoined by what is referred to as a lug 32.

Fig. 6b shows the holding element 26 from the side, with the collecting tube 25 from Fig. 5 being illustrated by dashed lines here. The collecting tube 25 has, in its upper region, a slot 25a which corresponds in terms of its dimensions in length and width to those of the lug 32. In order to secure the holding element 26, it is therefore firstly plugged with its lug 32 into the slot 25a in the collecting tube so that the lower edge 27a of the web 27 rests on the collecting tube 25. The side limb 30 has an curved lower edge 30a which is adapted to the contour 25b of the collecting tube 25. The same applies to the lateral limb 31 (not shown in Fig. 6b) which has a corresponding curved lower edge 31a. As a result, the two limbs 30, 31 rest with their lower edges over their entire surface on the collecting tube 25 and thus ensure that the holding element 26 remains in the position illustrated in Fig. 6b, i.e., in particular, does not tilt to the side. This is important if a flange for connecting coolant lines is attached to the central web 27 after the soldering. The holding element 26 is thus sufficiently secured and can be soldered to the condenser in the soldering oven without its position changing significantly.

Fig. 7 shows a soldered condenser 40 for an air conditioning system (not illustrated) of a motor vehicle. The condenser 40 is manufactured from aluminum materials and is soldered in one operation;

and it is composed of a tube/rib block 41 which has flat tubes (not illustrated in more detail) and corrugated ribs arranged between them. Collecting tubes 42, 43 into which the flat tubes open are arranged on both sides of the tube/rib block 41. In each case two holding elements 44, 45, 46, 47, manufactured by extrusion are attached to the two collecting tubes 42, 43 by soldering. The holding elements 44 to 47 have, at the ends, cutouts 44a to 47a which are used to attach the condenser 40 in the vehicle or to a cooling module (not illustrated). In addition, two flange connections 48, 49 for letting coolant in and out are attached to the collecting tube 43.

Fig. 7a shows the condenser 40 in a view from below, with identical reference symbols being used for identical parts, i.e. for the holding elements 44, 47, which have a flat section in this view, and the collecting tubes 42, 43.

Fig. 7b shows the condenser 40 in a view from the side in which it is clear that the holding elements 46, 47 engage around the collecting tube 43 from above.

Fig. 8 shows, by way of example, the holding element 44 as an individual part. The other holding elements 45 to 47 are basically of the same design. Fig. 8 shows the extruded section of the holding element 44 which is composed of an elongated holding plate 44b and a profiled foot 44c which has an extruded rib 50 and is illustrated as an enlarged detail X in Fig. 9. The holding plate 44b has a wall thickness s which is continuous with the foot 44c so that the necessary flexural strength is provided there.

Fig. 8a shows the extruded holding element 44 in a planar view with a width b which is a multiple of the wall thickness s. On the side facing away from the

foot 44c an approximately semicircular recess 44a is provided for attachment purposes.

Fig. 8b shows the extruded holding element 44 from the side, i.e. viewed from the foot 44c, i.e. the side facing the collecting tube (not illustrated here). The continuous, straight central rib 50 can be seen here.

Fig. 8c shows the extruded holding element 44 in a 3-D illustration with identical reference numbers being used for identical parts.

Fig. 9 shows, as already mentioned, the foot 44c of the extruded holding element 44 as a detail X from Fig. 8. The foot 44c has an approximately C-shaped section 51 which corresponds to the contour of the collecting tube 42 (not illustrated here) - see Fig. 7a. In the central region of this C-shaped section 51 the rib 50 is arranged as it were at the apex point of the C-shaped section 51. The C-shaped section 51 and the soldering face 51 which is formed by the C-shaped section has a plurality of grooves 52 which are arranged in parallel with one another and which are used to improve the soldering process and the soldering result. They bring about an improved flow and improved distribution of the solder during the soldering. The grooves 52 and the rib 50 run parallel to one another and in the extrusion direction.

In order to mount the holding element 44 or the holding elements 44 to 47, slots (not illustrated) with the dimensions of the rib 50 (see Fig. 8b) are provided in the collecting tubes 42, 43, the ribs being inserted into said slots and caulked to the collecting tubes. The holding elements 44 to 47 are thus secured for the subsequent soldering process.

Fig. 10 shows, in an exploded illustration, a further exemplary embodiment of a flange 60 (referred to as a

tube connecting flange) which is constructed as an extruded part and has an integrated, i.e. single-piece holding element 61. The flange 60 is of similar construction to the flange 7 in Fig. 3 and has two connecting openings 60a, 60b and two attachment bores 60c, 60d. The holding element 61 has a concave section 62 and a longitudinal groove 63 at the apex point of the section 62, i.e. running in the extrusion direction. The flange 60 is attached to a collecting tube 65 by means of a securing element 64, which collecting tube 65 has an opening 66 for inserting the securing element 64. The securing element 64 is of approximately T-shaped construction, i.e. with a narrow projection 64a and a wider piece 64b which can be inserted into the groove 63 of the holding element 61 in the manner of an adjusting string. The narrow projection 64a is inserted into the opening 66 and caulked there. The holding element 61 is then fitted, with the longitudinal groove 63, onto the piece 64b so that the concave section 62 surrounds the collecting tube 65. The flange 60 is thus secured sufficiently with respect to the collecting tube 65, i.e. it can now be soldered - to the connecting tubes (not illustrated) - in a soldering oven (not illustrated).

Fig. 11 shows the flange 60 ready mounted with the collecting tube 65. The concave section 62 of the holding element 61 fits snuggly against the circumference of the collecting tube 65 and forms a soldering face with it. The securing element 64 penetrates the collecting tube 65 and is caulked from the inside with its projection 64a against the collecting tube 65 so that a positively locking and/or frictionally locking connection is produced. The piece 64b which projects out of the collecting tube 65 is caulked into the longitudinal groove 63 so that a form fit and frictional connection is also produced here. As a result of this securing method further soldering aids and subsequent mounting work are superfluous.